Idiacanthus antrostomus

"Life can survive unimaginable environments."

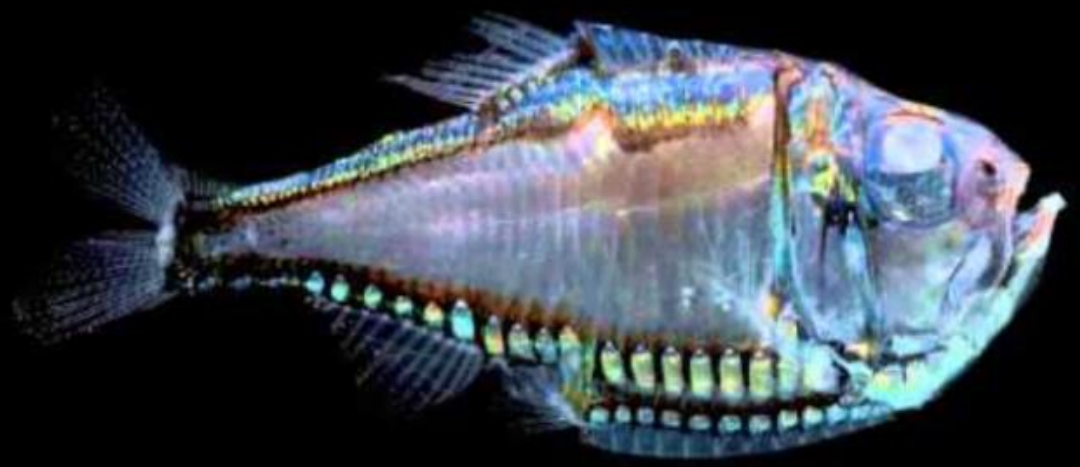
Extreme Habitats I: Deep Sea Fishes

FISH 310

Common anatomical modifications of deepwater fishes

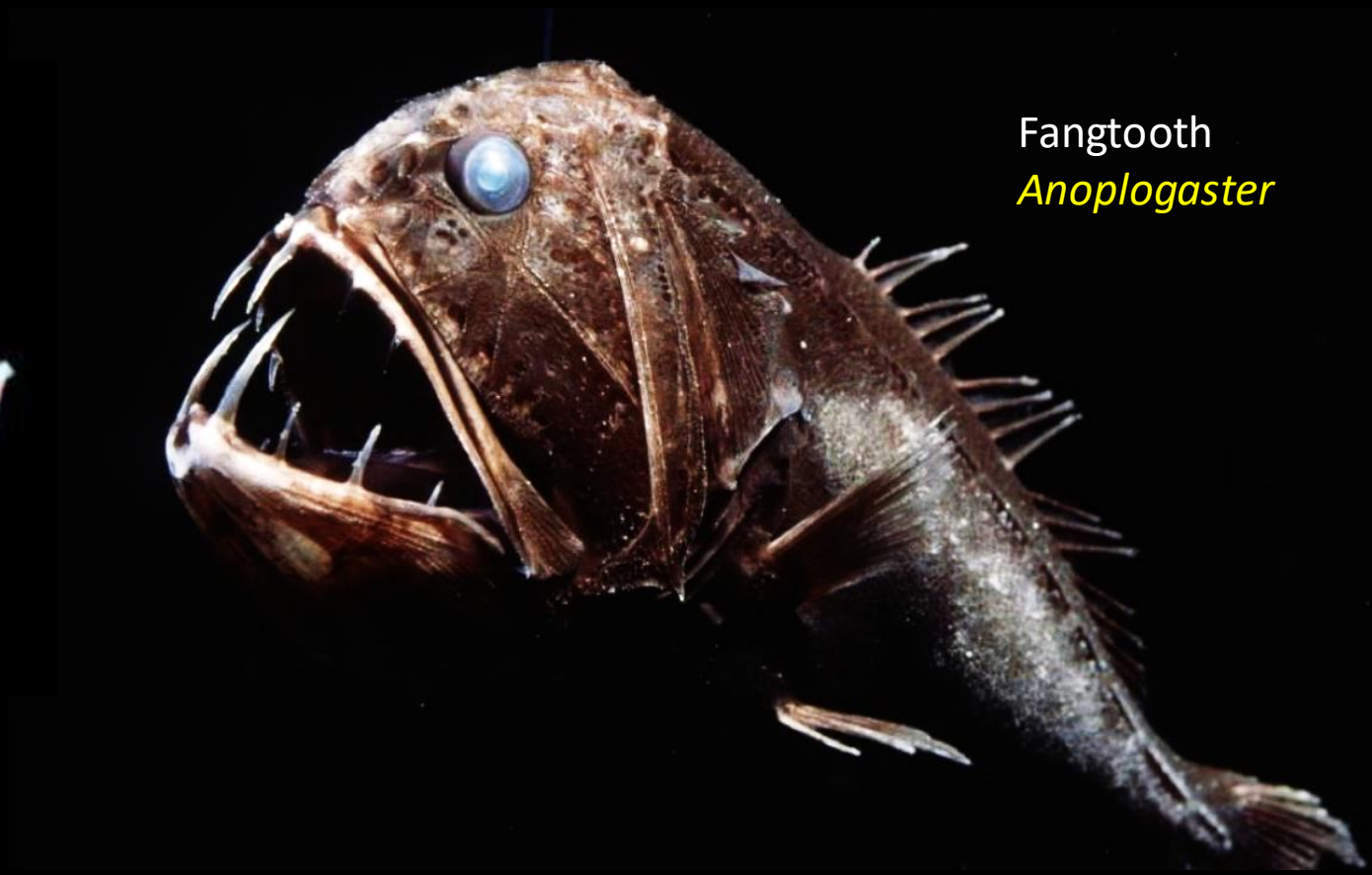
photophores

Deepsea Hatchetfish
Sternoptychinae



large mouths

Fangtooth
Anoplogaster



Common anatomical modifications of deepwater fishes

Pacific blackdragon
Idiacanthus

lures

Scaleless Dragonfish
Chirostomias

long, thin bones

Common anatomical modifications of deepwater fishes

reduced eyes or tubular eyes

Flabby Whalefish (female)
Cetomimidae

Common anatomical modifications of deepwater fishes

reduced eyes or **tubular eyes**

Telescopefish
Gigantura

Barreleye or Spookfish
Macropinna

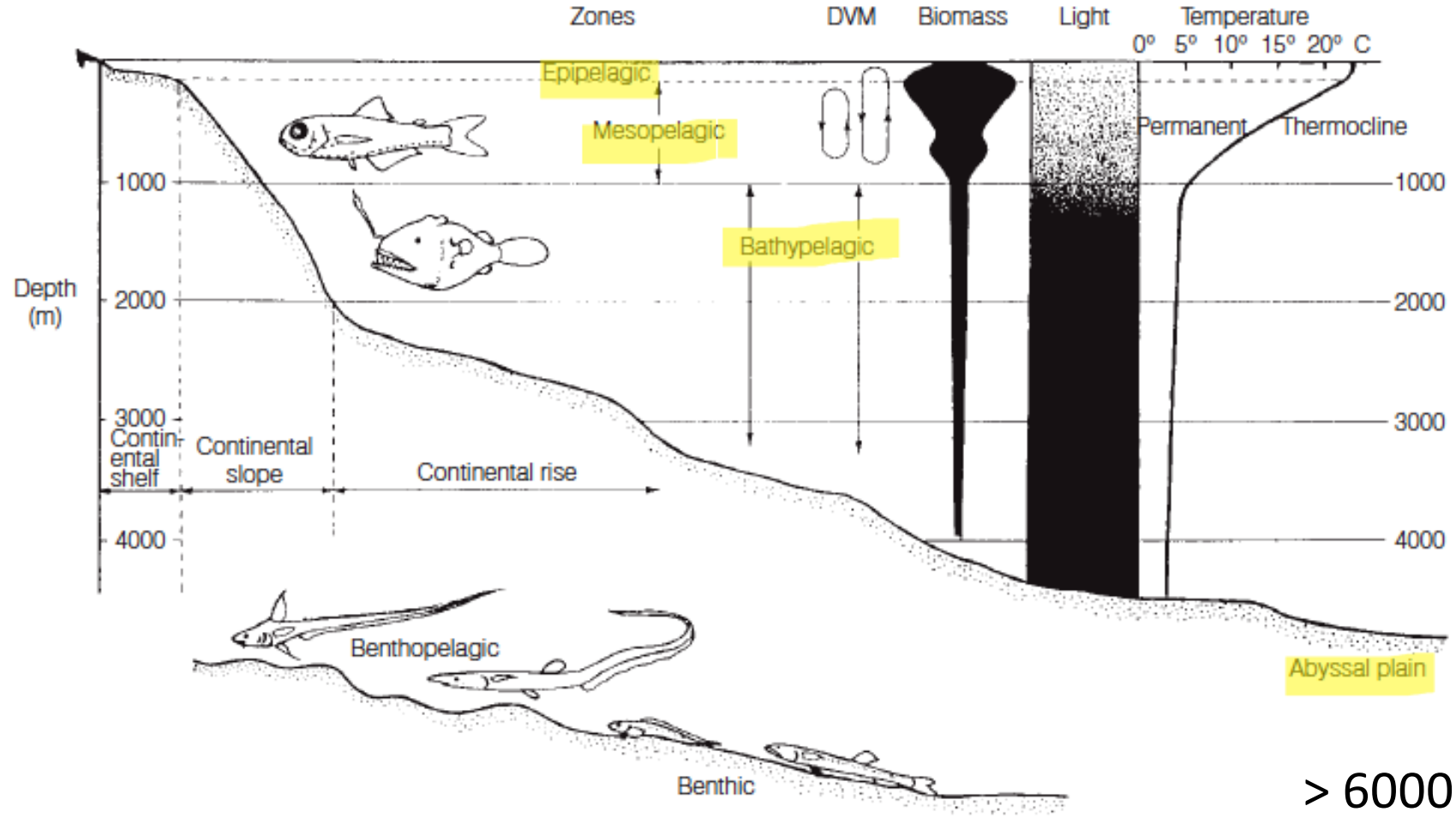
Today's roadmap

1. Regions of open water & the deep sea
2. Physical factors that affect deepwater fishes
3. Morphological adaptations of deepwater fishes
4. Convergent evolution in deepwater fishes

Telescopefish
Gigantura

Major regions of open water

So, how deep is the ocean?
https://neal.fun/deep-sea/



> 6000 m = **hadal** zone

Figure 18.1

Regions and physical features of the deepsea environment relative to depth. Representative species are a mesopelagic lanternfish, bathypelagic ceratioid anglerfish, benthopelagic rattail and halosaur, and benthic snailfish and greeneye. Many mesopelagic species undergo a diurnal vertical migration (DVM) to shallower waters at dusk, returning to deeper water at dawn. Total biomass of living organisms, available light, and temperature all decline with depth in the deep sea. From Marshall (1971), used with permission.

The **pressure** of life at depth

700-800 atm
(12000 lbs/inch)

Abyssobrotula galatheae
8370 m

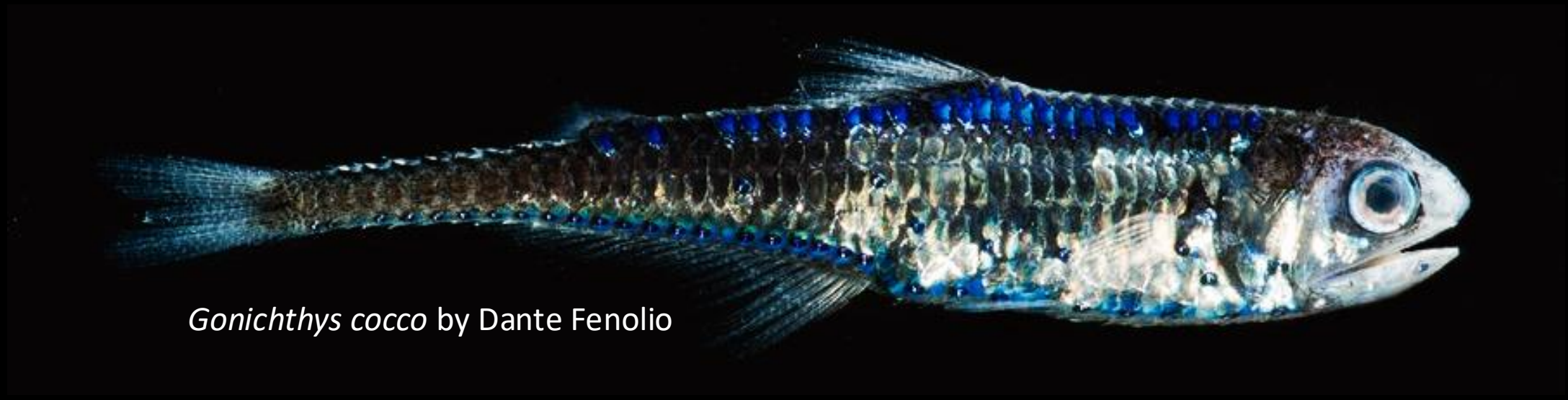
Bassogigas profundissimas
7160 m

Buoyancy mechanisms of deepsea fish

1. **Lengthened rete mirabile:** < 1mm long in epipelagic fishes, 1-2 mm in upper mesopelagic, 3-7 mm in lower mesopelagic, and 15-20 mm long in some bathypelagic fishes
2. **Loss of the gas bladder:** Reduced skeleton & musculature → appx. neutral buoyancy
3. **Lipid-filled gas bladder**: Lipids are incompressible & lighter than water
4. **Secondarily physoclistous**: physostomous fishes have closed the pneumatic duct to prevent gas from escaping out the mouth!

Temperature at depth

- Predictable decline of temperature correlated with increased depth
- **Permanent thermocline** until bathypelagic region: 2-5º C
- **Strong predictor** of deepwater fish distribution
- **Tropical submergence:** mesopelagic @ high latitudes may be bathypelagic @ low latitudes
- Vertically migrating fish swim through ~ 20º C temperature range!



Gonichthys cocco by Dante Fenolio

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Finding a **mate** in the vast darkness

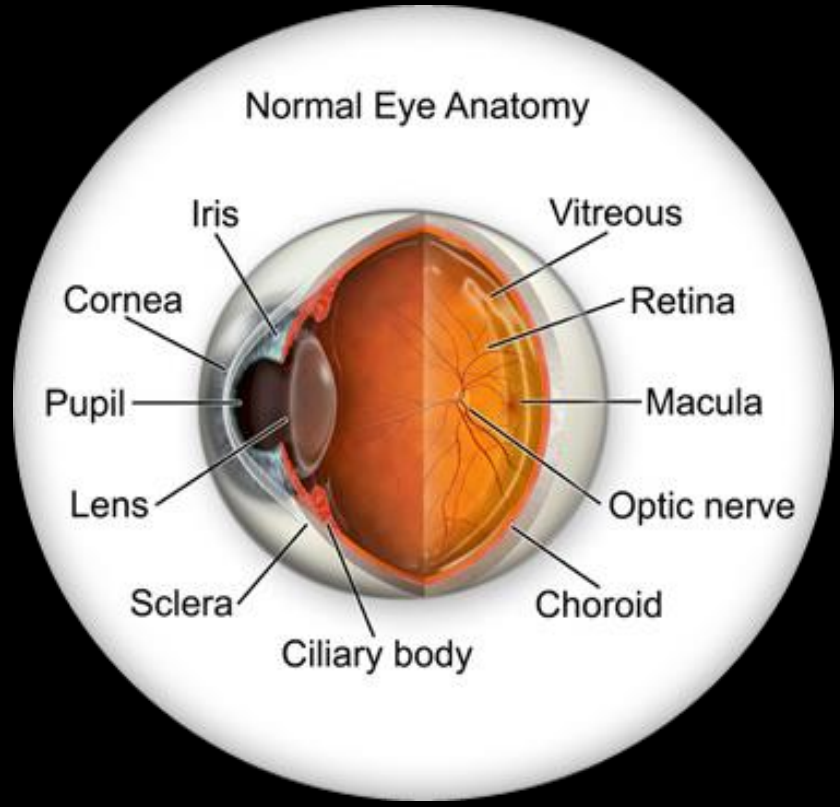
- Imagine searching for a football in a dark football stadium…
  - Extreme sexual dimorphism!

Figure 18.2

Size differences in male versus female anglerfishes. A 6.2 mm parasitic male *Photocorynus spiniceps* (Linophrynidae) (circled) attached to the dorsal area of a 46 mm female. Inset: a free-living, 18 mm male of *Linophryne arborifera* (Linophrynidae), showing the greatly enlarged eyes and olfactory lamellae apparently used in finding females. From Pietsch (2005), used with permission; photos courtesy of T. W. Pietsch.

Harnessing light

- Visible light vanishes by 200-800 m (depending on clarity)
- Deepsea fishes 15-30x more sensitive to light, can detect @ 700-1300 m
- Mesopelagic zone = “twilight zone” (bathypelagic completely dark)
- Blue-green wavelengths (~470 nm) are all that’s visible
- Mesopelagic fishes have pure **rod** retinae sensitive @ 470 nm, matching light environment + photophore light production



Harnessing light

- Elongated eyes:
  - Aphakic/lensless space between pupil and lens
  - Retina-containing vitreous portion elongated
- Bioluminescence
  - Camouflage
  - Identification of the emitter
  - Illumination of nearby prey

Deepsea Hatchetfish
Sternoptychinae

Stoplight loosejaw
Malacosteidae

Finding food

https://nautiluslive.org/video/2018/09/20/gulper-eel-balloons-its-massive-jaws

- All marine food chains originate in the **euphotic zone** (3% of the ocean!)
- Foraging adaptations like daggerlike teeth, expandable mouths, hinged jaws, distensible stomachs

Gulper Eel
Eurypharynx pelecanoides

Sloane's viperfish
Chauliodus sloani

Finding food

- All marine food chains originate in the **euphotic zone** (3% of the ocean!)
- Foraging adaptations like daggerlike teeth, expandable mouths, hinged jaws, distensible stomachs
- Dorsal spines modified into esca-tipped illicium in anglerfish

Figure 18.4

An adult female wolftrap angler, *Lasiognathus amphirhamphus* (Thaumatichthyidae), about 15 cm long. The rodlike structure pointing tailward is the skin-covered caudal end of the dorsal spine that forms the illicium. The spine slides in a groove on the head, allowing the anglerfish to move it forward when fishing but to retract it otherwise. Photo courtesy of T. W. Pietsch.

Preserving energy

- Elimination of heavy components of the body (skeleton, musculature)
- Free neuromasts instead of canal neuromasts
- Slow metabolism
- Sedentary lifestyle

How do you evade predators with little to no trunk musculature?

Goblin shark
Mistukurina owstoni

Okinawa Churashima Foundation

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Gigantura

Convergent evolution

Gonostoma denudatum

G. bathyphilium
(Now *Sigmops bathyphilus*)